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VENTILATION.



A PAPER READ BEFORE THE

MEDICAL CHIRURGICAL SOCIETY,

OF MONTREAL,

BY DR. HOWARD,

Medical Superintendent of the Provincial Lunatic Asylum, St. Johns,
Province of Quebec.

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PREFACE TO THE LECTURE.

It is told of Dr. Johnston, that once when his friend Pope asked him "what was a note of interrogation?" Looking at the little man, he answered him rather roughly, "It is a little crooked thing that asks questions."

There are very many persons to be found who are simply notes of interrogation—who fancy it is a very wise act, and that every man who does not answer, all their questions is simply a fool. With regard to my system of ventilation, I beg to say that either Mr. Marchand, [the manufacturer] or myself are prepared to give all information on the system that may be demanded of us, but neither of us bind ourselves to loose our time answering every question that every interrogator may think of asking, particularly when it is quite obvious that the object of the question is fault finding.

For example, when Mr. Marchand was engaged ventilating the Court House, one gentleman, who had read my pamphlet, said to him: "When the atmospheric air is warmer than the air in the building, what becomes of Dr. Howard's theory, the foul air must then remain close to the ground." The simple answer to this question is quite obvious, [though Mr. Marchand should not be supposed to answer it.]

That when a building is ventilated, it is supposed to be inhabited, or that at different times crowds of people collect in it. When this is the case, no matter how warm the atmospheric air may be, the heat from the legs and the bodies of the persons, so assembled, is greater than that of atmospheric air, and it is these impure hot gasses from the person that are expelled from the building by my system of ventilation. If the object was to take carbonic acid gas out of a vault, or an old, dried up well, of course, as I have already explained, the case would be different. Then indeed, the exist shaft or hose, should go down to the bottom of the vault of well.

Another anxious to find fault says: "How comes it that in this room, which is 22 feet high, you have the exit shafts within 2 feet of the ceiling, when Dr. Howard in his treatise says the foul air should be drawn off at a height of from 7 to 9 feet." Had this gentleman only considered that I had no rooms at the Asylum to experiment in over 12 feet high, he would have waited for more light on the subject, and would have found everything explained to his satisfaction in the discussion

that took place, when I read my paper before the Medical Chirurgical Society of Montreal.

The few remarks made by Dr. R. P. Howard settled that question. To be certain at what height the exit shafts should be, we have simply to test the room to be ventilated, as I had Mr. Marchand to do in the Court House. One thing is certain that the foul air won't be found *under* from 7 to 9 feet.

I must now anticipate another question which is sure to be asked, viz: "What of a new building, when it is erected." As a rule I would say to have the exit shafts between 2 and 3 feet from the ceiling.

Two court rooms in the building are now ventilated with one foul air expeller, and every one can see that it is a perfect success. This has been proved by the usual tests.

H. HOWARD, M. D.

MEDICO-CHIRURGICAL SOCIETY OF MONTREAL.

MEETING HELD, APRIL 28TH, 1871.

The President G. W. CAMPBELL, A. M., M. D., in the chair. The minutes of the last meeting were read and confirmed. The President then introduced

Dr. HENRY HOWARD, Superintendent of the Provincial Lunatic Asylum, at St. Johns, P. Q., who read the following paper on his system of "Ventilation."

MR. PRESIDENT AND GENTLEMEN,—The subject which I beg leave to bring before you this evening (my system of the ventilation of buildings) requires no proof of its actual necessity, or of its importance in a sanitary point of view. You all know its importance just as well as I do. My system of ventilation I wish to be considered and discussed, by this Society, and that members should give their fair and candid opinion upon it without any prejudice. If you find it what I believe it to be, you will give me credit for it; if on the contrary you differ from me you will honestly give your reason why. Allow me for a moment to digress. I know there are many in this city, whom I fear are very ignorant of any system of ventilation, and when speaking on the subject begin to sneer at all systems. Men of such pretended knowledge, may (perhaps inadvertently) do a great deal of harm, without being able to offer any opinion, or suggestion, that would be of any benefit in a question of such vital importance. The majority of the medical and scientific men of the present day, have embarked in the subject of ventilation in order to secure some certain means of preserving the health of their fellow creatures. It is not the time through selfish motives, or egotism, to oppose instead of endeavouring to forward it. If such men are not capable by their own talents too add something to science, at least they should do so by encouraging all and every individual who is working hard for the sake of humanity. I believe, sir, it is a recognized fact that Dr. Parkes of the Royal Victoria Hospital, Netley, England, is one of the best authorities, in the present day, upon Hygiene, and I know that the high and responsible position that he holds, is due to his work on that subject. He certainly has grappled with the matter well, and has proved the errors of many old and new theories. So far as wind, sewerage and foul gases are concerned, I have carefully studied his work and have adopted his theory: that foul air should be drawn off above, and not below the person, and that pure air should be admitted in a similar manner. That the great object in ventilation was to expel foul air as soon

as possible after it was exhaled or generated, and admit pure air to take its place. That there should, in fact, be two distinct currents always going on in the place to be ventilated, and all this should be done without producing sensible draught.

Dr. Parkes in his work gives all the different means that had been invented to accomplish this end and concludes that they were all imperfect from one cause or another. To depend upon the wind was absurd, for we have no control over it, and when most wanted, very frequently there was none; again it changes so often that tubes which a few minutes before were outlets, suddenly became inlets, and very frequently all the shafts would be inlets. Heat, steam, water, and horse power were all found too cumbersome, or expensive for general use; so all were given up in turn or left in their imperfect state, I suppose on the principle, better something, than nothing and that the very look of the thing made people believe that ventilation was going on. Observing these facts, I turned my attention to see if I could not invent some means to carry out Parkes' theory (independent of heat, steam, water, horse or man power). To ventilate my most miserable make-shift of a building, crowded with the very worst class of lunatics, no man could have a better opportunity than I had of experimenting. My first set of experiments were to find out how impure grass were diffused through a chamber where there was no means of admitting pure air, nor any means of expelling foul. The result of these experiments was, that the foul gases were pretty equally diffused through the chamber, but that there was a greater quantity higher up, than lower down. From many such experiments I found that the room began to fill from above downwards. My next experiment was to see if I admitted air into the chamber upwards and inwards, (and this idea was my own) without any exit shaft, what would be the result. It was then that I found the first effects of impure gas, about 9 ft. from the floor, but generally *all* my tumblers of lime water and leaded paper became affected in a more or less degree. My next experiments were the same as the last, with this addition, that I made an exit shaft through the roof of the Asylum, and put a movable cowl upon the top of it. When this shaft acted as an exit, which was not always, I found that the pure air was below 7 ft. and near the floor; and that from 7 to 10 ft. was the greatest quantity of impure gases, though heated air was much higher, and while the air under 9 ft. was heated, yet there was but very little impurity in it. This experiment I tried very often, before I was satisfied with it, because as I have already said, sometimes my exit shaft acted as an inlet, at the very time I wanted it to act as an outlet.

From the foregoing experiments often repeated I came to the following conclusions.

1st. That the proper height at which to expel foul air is between 7 and 10 ft. from the floor.

2nd. That external air when admitted above the head inwards and upwards causes no sensible draught upon the person.

3rd. That this air when colder than the internal air fell down towards the floor and while passing through the heated and foul air, though it

became in some degree heated, was not impregnated, but very slightly effected with impure gases, it after descending kept floating up the impure gases; in fact there were two distinct currents, the foul gases and heated air *ascending*, the cold pure air *descending*. I know that the question has been asked "How can pure air pass through impure gas and not become impregnated with it?" The answer to this question is, that air is a mechanical mixture and not a chemical compound, and I do not say that if the foul gas is not drawn off, and that quickly, that the whole will not become *impregnated* and impure. But if according to my system, the foul air is drawn off quickly, there is hardly time for the pure air to become even soiled. Here I wish it to be particularly understood that I do not say heated air is foul air, but that heated air and heated carbonic acid and sulphuretted hydrogen gases are lighter than pure cold air and consequently are floated up together,—the heated pure air, however, ascending much higher than the heated impure gases. In fact, the heated pure air will rush out through an open shaft if there is any draught, whereas the impure heated gas, as soon as it gets cold in the shaft, will fall down again unless there is a strong power to force it through.

The foregoing facts founded upon experiments, led me to put tubes through every part of the Asylum, all connecting with the main shaft that ran out through the roof of the house, and had a cowl upon it.

It was at this time that I invented an instrument for the admission of pure air into buildings and which for want of a better name I called a ventilator. One of these ventilators I placed in every window of the Asylum in the place of a pane of glass. You will ask me did these ventilators, exit tubes, and movable cowl purify the Asylum? I at once answer *No*. The state of the Asylum was very much improved indeed, but it was by no means perfect ventilation, simply because my exit shafts as often acted as inlets as they did outlets, and when there was no wind there was no draught in the shafts at all. I then invented an exhausting machine to take the place of the cowl, its movements however depended upon the wind; when it was working it did purify the Asylum perfectly, but when there was no wind it was of no use. It had one great advantage over the cowl, and that was, that I never had, with it, down draughts. I, at that time, frequently tried my experiments over again till I became perfectly certain that I had got the right mode of ventilation, if I could only succeed in having a motive power to work my exhauster, or foul air-expeller, independent of wind, steam, water or horse-power. I saw that the true principle was to have such a force as would suck up the foul gases independent of the pressure of the air from below, in fact, that it should be pumped out, as was water is from a well. I determined, if possible, to invent a foul air expeller, respecting which I would be certain that its action would be always equal, and independent of wind or weather. To accomplish this has caused me many a weary hour, and many a sleepless night, and more money than I am inclined to tell. Generally the fault was some miscalculation, or some mathematical error, and again the fault would be, want of a perfect machinist capable

of carrying out my views. Often I felt inclined, and was advised to give it up; but I still persevered, and I now feel satisfied that success has crowned my efforts. The machine which hereafter I will describe takes a man six minutes to wind up, then it runs for twelve hours, in fact it runs 20 inches of cord an hour, so if you have sufficient fall for the weight, you can run it as many hours as you please.

It was visited by a number of scientific gentlemen from Montreal, some of whom are here present. They found that I had a main tube made of tin, air-tight, and 8 inches in diameter, running from one end of the Asylum to the other (130 ft.) which terminated in the transit shaft of the machine. Into this main tube there were 20 tin tubes from the different apartments of the Asylum to be ventilated; these were four inch tubes, and I told the gentlemen present that I feared I was giving the machine more work than it could do. Some days afterwards, upon close examination, I found that all the tubes did not draw with the same force, and that the tubes furthest from the machine were those that were working best. After spending four days trying to find out the cause of this, I concluded that my four-inch tubes were too large and that the pressure of the air from below upwards was acting in some degree upon the shafts, when my object was that no air should be removed except by suction, like a pump sucking water out of a well. I removed the four-inch tubes and replaced them with one-inch tubes.

The effect was most satisfactory, the suction immediately became equal in the twenty tubes, and much more powerful, drawing a much greater quantity of foul air than with the four-inch tubes. I by this discovered that the machine is fully capable of exhausting 20 one-inch tubes, 10 two-inch tubes, 5 four-inch tubes; so, to ventilate any building now is a mere matter of calculation. When I had this work perfect I made the following experiment. In the women's day room, where there were two exit shafts and a ventilator in each window [that is four windows,] there were in the room 36 lunatics. The room is 31 by 39 ft., and 12 ft. high. I placed graduated tumblers of lime-water from the floor to the ceiling, and did the same with leaded paper. I also placed three thermometers on the same post, one on the floor, one at 7 ft. and one up close to the ceiling; the exit tubes are 9 ft. from the ground. After leaving these for four hours, the following was the result. There was hardly any change in the lime-water, and papers, except between 7 and 10 ft., even here it was not very visible; the thermometers ranged thus, the one close to the floor 70° , the one 7 ft., from the floor 74° , and the one 12 ft., 80° . This experiment fully proved the pure state of the chamber. *Secondly*.—That where foul gases were to be found was between 7 and 9 ft. *Thirdly*.—That though the heat was greater at the ceiling it did not bring up with it the impure gases, but that the pure air floated it up to the height from which it was drawn off, viz: 9 ft. * *Fourthly*.—That though the cold outside air admitted from above inwards and upwards, it was to be found

* According to Haswell's Tables and formula.

nearest to the floor. You may say what benefit is to be derived from the charcoal and small piece of cotton wadding in the ventilators: Is not the outside air pure enough? I answer you that in the first place, the cotton wadding breaks the force of the wind and obstructs the entrance of organised and disorganised matter; secondly, that the outside air is not always pure, and the carbonic acid gas is absorbed in the charcoal. As a proof of this, I made the following experiment on Saturday the 22nd of this month. I placed in the sleeping room of the men and in that of the women also (no one being in the rooms), a glass of lime-water. I also placed one in the sitting-room of the women (42 present) one in the sitting-room of the men and one on my gallery in the open air. After three hours the following was the result: in the sleeping rooms there was not the slightest sign of carbonate of lime: the water in the open air and sitting-rooms were alike,—just sufficient to see that there was a change in the water.

The exhauster expels 4,500 feet of air every hour. It will therefore entirely change the air in a building 90 ft. long by 60 ft. wide by 20 ft. high once a day.

If the exit shafts open 9 ft. from the ground of the occupied rooms, it will pump up 54,400 feet of foul air every 12 hours. The area of the inlet, that is, where the air enters the fan box, is 144 square inches, the area of the outlet, or where the air is thrown off from the fan, is one-eighth of this, or 18 square inches. The circumference of the fan box is 11 inches, and the velocity of the fan is twice a second or 120 revolutions a minute. I think, gentlemen, you will agree with me that my experiments are conclusive and that I have carried out my theory to a practical result.

DR. GEORGE W. CAMPBELL said it had afforded him much pleasure to listen to Dr. Howard's paper. The merit of his discovery was the proposal to pump out all the foul air.

DR. TRENHOLME enquired if Dr. Howard knew the exact amount of foul air which he expelled in a given time.

DR. HOWARD said he had given it to one of the best mathematicians in the County to work out, and his result was 54,000 feet every twelve hours.

DR. TRENHOLME asked if when Dr. Howard reduced the size of his tubes from four to one inch, the fan revolved more rapidly, and if the same amount of foul air was expelled.

DR. HOWARD said it did, and the foul air expelled was the same, upon the same principle that a similar quantity of water was sent through a small hose as a large one.

DR. REDDY enquired the length of the exit tube.

DR. HOWARD said its width was one-third of the whole circumference: its length—as you choose. There was always more foul air at the exit of the tube than at any other part.

DR. DAVID asked if Dr. Howard could assign any reason why the foul air did not rise higher than 9 feet.

DR. CRAIK said Dr. Howard explained that the gases were heavier

than the heated air, which being lightest goes to the top—the foul gases go up till they become the same weight as the air, and then stop.

DR. TRENHOLME would like very much to see Dr. Howard's experiments carried out in a large and lofty room.

DR. R. PALMER HOWARD, said that Sulphuretted Hydrogen, and Carbonic Acid were heavier than atmospheric air, but when heated became lighter, and that the position of the foul gases, as discovered by Dr. Henry Howard, was just such as we would naturally expect from well-known physical laws. If the room should be 20 feet or more high—the height at which most foul air would be found, would be more than 9 feet, but this did not affect the discovery, which he considered an invaluable one. The simplicity of the clock work was admirable, steam being very expensive. The revolution of the fan must produce a vacuum, and it was a mere matter of calculation as to the size of the receiver. The economy of cost and its certainty of producing a vacuum were points of merit in the invention.

DR. G. W. CAMPBELL suggested the idea that in cities it might be cheap to drive the fan by water-power, a very small pipe would he thought, answer the purpose.

MR. ROBERT MITCHELL, [steam fitter, &c.,] said water was far too costly to be used for such a purpose, in fact, it was the most expensive method that could be adopted.

DR. CRAIK desired further light on the subject. He felt somewhat uneasy as to how the heating of houses in winter would be affected, when this method of ventilation was adopted.

DR. HOWARD replied that the past winter had been an exceedingly cold one, and so far as he had observed in the Asylum at St. Johns, the temperature of the building was not effected in the most remote degree; the ventilator was open all the time, and there was not the first complaint of cold. The Asylum was heated with wood.

DR. CRAIK asked if he [Dr. Howard] thought that the same result would have been arrived at if the place had been heated by steam or hot air.

DR. HOWARD said he had no experience upon which to base a reply, but he thought under circumstances such as were mentioned by Dr. Craik there might be a little loss, but not sufficient to make it of the least importance.

DR. CRAIK enquired if Dr. Howard had tested for organic impurities in the gases. Condry's fluid in tumblers would give the means of testing for them. These organic impurities were drifted by currents, but when these ended they gravitated downward.

DR. FENWICK said this question had already been settled. Many impurities adhere to the walls of the room, and also to the bed clothing.

DR. CAMPBELL, the chairman, then said; "Dr. Howard, on my own part and the part of the society, I thank you. I am convinced from your paper and the ensuing discussion, that you have at last hit off the true principles of Ventilation."

The Society then adjourned.

EDITORIAL COMMENTS.

From the Canada Medical Journal.

The subject of ventilation of public buildings has long engaged the attention of sanitarians; and of the various methods proposed, all present some objectionable point, so that perfection has not, so far crowned the efforts of those who have devoted their energies in this direction.

Dr. Henry Howard of St. Johns, the worthy superintendent of the Provincial Lunatic Asylum, of the Province of Quebec, has been forced to enter the lists in sheer self-defence. A more wretched building does not exist on this Continent, possessing the name of a lunatic asylum, than the institution over which he is forced to preside. The building was a few years ago used as a court-house, although we believe it was not originally built for that purpose. At the time of the Trent difficulty, when the Imperial Government in their wisdom sent an additional military force to this country, the old barrack at St. Johns, which had been selected by the Canadian Government as a temporary lunatic asylum, was re-occupied for military purposes by the Imperial authorities. Dr. Howard was forced to relinquish that site, and the present building which he occupies was temporarily given for his use, in lieu of the more extensive and commodious buildings known as the St. Johns barracks. We have repeatedly entered a strong protest against the present system, as more expensive than would be the erection of a new building; expensive in every respect, as it is utterly impossible to adapt such a building for the purposes of a lunatic asylum, besides which the constant outlay on a old building, the alterations necessary, the patching and repairing, in the long run costs more than a new establishment. But what should weigh more in the counsels of those whose business it is to provide such establishments is the fact that there is no chance of benefit being derived by the unfortunates confined there. As to the scientific treatment of the insane under such circumstances, it is out of the question. There is, therefore, every reason on the score of economy, if on no other grounds, for a change in the present system. The sooner the Government of Quebec adopt the idea of change in this respect, the better for the country at large, and the sooner will be removed the stigma of possessing a building in which afflicted human beings are housed which is hardly suitable for animals of the porcine species.

We say that Dr. Howard in sheer self-defence was forced to seek some efficient means of improving the air of his Asylum. From personal inspection we can bear testimony to the success of his efforts. When some five years since we visited his Asylum, we were simply horrified with the condition of things. Improvement certainly has followed on his exertions, and we have reason to know that these experiments have been attended with considerable outlay. We presume that the expense of these various trials or experiments has been borne by himself, as we all know that in Government enterprises great care is adopted to prevent unnecessary outlay, every farthing has to be satisfactorily accounted for, and the expenditure of large sums of money for mere experimental pur-

poses would not be allowed. We visited the Asylum at St. Johns in April last, and rooms and dormitories which were in 1865 pestiferous, were in 1871 sweet and endurable. No more positive evidence, therefore, can be adduced of the success of Dr. Howard's method of ventilation than the results observed in his own Asylum.

Dr. Howard's system consists in the admission of fresh air at the upper part of a room; the air passes along the ceiling and falls as spray to the floor; in its transit it must to a certain extent mix with the foul air of the apartment, but only to a slight degree, while the latter being of higher temperature, is floated to the upper strata, and is carried off by an upward shaft at the ceiling. This shaft is in connection with an air-tight receiver, having within it a fan of four blades; this is kept constantly revolving by means of a clock-work arrangement and weight; to the receiver is attached a discharge tube, which passes out above the roof of the building. The revolution of the fan produces a vacuum, and must draw the air through the tube which opens at the ceiling of the apartment to be ventilated; this air is then forced through the discharge tube, and is rapidly diffused or carried off by the wind.

From experiments instituted by Dr. Howard it would appear that the largest quantity of foul air in a room twenty feet high, when there is defective ventilation, is about two feet from the ceiling; a room of the same height yielded a large portion of foul air ten feet from the floor, but there was almost perfect absence of impurities at the ceiling and at the floor. From these facts it would appear that a discharge tube would be more efficient if opened at two feet from the ceiling in an apartment of twenty feet in height, and one foot in a room of ten feet altitude.

We need hardly allude to the urgency of ventilation. To secure a healthful condition of the body, constant change of the air of an apartment is an absolute necessity. The emanations from our bodies are such as to render any apartment in time highly poisonous, so much so, as to preclude the continuance of life. Decay is constantly going on in our bodies, and an arrest of these changes is inconsistent with these continuance of life. The problem consists in getting rid of these effect particles after they have been separated from the living mass. Hence the urgency of adopting some rational system of ventilation. More especially is this urgently necessary in public buildings, schools, gaols, lunatic asylums, churches and other buildings where large numbers of persons are met together.

The Court House of our City has been long known to be very deficient in ventilation. So much so that on more than one occasion the Judges on the Bench have been obliged to relinquish their official duties through indisposition. The Quebec Government have wisely determined to endeavour to improve the present state of that building, and we believe that Dr. Howard has in hand the contemplated improvement. If he succeeds as well as he has in the Lunatic Asylum at St. Johns, it will go far to secure the confidence of the public in his invention, and will we trust, lead to the adoption by other ill-ventilated public buildings throughout the country of the Howard system of ventilation.

The Editor of the *Montreal Herald* of July 21st, says :—" The propriety of ventilating every building, for whatever purpose it is occupied, has not yet been recognized. The fact is beginning slowly and gradually to penetrate the public mind, that buildings in which human beings meet, or in which they live, should have some means provided for carrying off foul and providing pure air. In an article published in a late number of the *Canada Medical Journal*, it is stated that the experiments of Dr. Howard at the Lunatic Asylum at St. Johns, have been successful. The writer states that when he visited the Asylum, in 1865, he was horrified with the condition of affairs. The experiments, however, carried on by Dr. Howard, at his own expense, were so effective, that last April, when he again visited the institution he found the air sweet and endurable, and believes that no more positive evidence could be adduced of the success of Dr. Howard's method of ventilation, than the result observed in his own asylum."

The Editor of the *Franco-Canadien* of St. Johns, says :—" We have ourselves examined in each particular, and are acquainted with Dr. Howard's Patent Exhauster, and we believe that its success is perfectly established by the trial it has undergone in the Asylum of this town. Nothing, in fact, is more perfect than the ventilation of this establishment. As to its application to the Court House, in Montreal it has given, since our preceding article was written, proofs as satisfactory as can possibly be, in favour of the system. It stands proved to-day that Dr. Howard's invention is a complete success and that it deserves to be applied without delay to all our public buildings, and particularly to the Houses of Parliament at Quebec whose ventilation is so imperfect. The moderate cost of its introduction is a further consideration which especially recommends it."



